

UNPUBLISHED PRELIMINARY DATA

Columbia University in the City of New York
Lamont Geological Observatory
Palisades, New York

Six-month Status Report: March, 1964 - August, 1964
Grant NsG 232-62

Research on Quantities and Concentrations of Extraterrestrial
Matter through Samplings of Ocean Bottoms.

Principal Investigator: William A. Cassidy

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I. Work Accomplished

The principal investigator was out of the country during three months of the grant period reported here, therefore a three-month extension of the grant period without additional funds was requested and received. The work through August reported here thus represents a relatively modest addition to the accumulated total. During this time a major objective of the work continued to be the separation of microscopic cosmic material from ocean sediments. The collection and examination of trawl samples was continued and further progress was made on techniques of microanalysis of individual grains by nondestructive neutron-activation irradiation. These activities are discussed in more detail below.

A. Magnetic and non-magnetic separations on flow-in samples.

In all, we have now processed flow-in samples from eight different geographic points.

In the last report it was noted that three transparent, apparently glassy, nonmagnetic spherules of natural origin had been found in the magnetic fraction of flow-in mud from one site on the abyssal plain of the Argentine Basin. Similar spherules have been reported in the dust residues found in ancient ice by other workers and it was pleasant to be able to note their recovery at this laboratory also. It is now almost certain,

however, that these transparent spherules result from artificial contamination of the sample, and have nothing to do with that fraction of the sediment that is cosmic in origin.

This casts doubt on the origin of the other transparent spherules that have been reported, and the following details should be carefully considered by other workers in this field. The spherules are pellets of ion-exchange resin that have been introduced into some of the samples during cleaning and examination. They are found in Deeminac brand ion-exchange filters produced by Crystal Research Laboratories, Inc., Hartford, Connecticut. Examination of one of these cartridges, which had been used in processing the sediment sample from which the transparent spherules were recovered, showed that the ion-exchange resin was in the form of millions of tiny, transparent, perfect spheres which were indistinguishable from the transparent spherules that had been found in the magnetic fraction of the sediment. This source of contamination was found after attempts to analyze the spherules by neutron activation failed to indicate the presence of rock-forming elements. These data are discussed in Section D. 2.

B. Polished-section examinations.

This remains a part of the research program but nothing was done on it during the period of this report.

C. Trawling collections.

Results of argon analysis on fine-grained magnetic separates from red clay have been reported by Merrihue. His results, on trawl material supplied by this laboratory, indicate that the argon most firmly fixed in the crystal structure of the grains, i.e., the argon released during the last stage of heating in the range 1200-1400°C, is significantly lighter than present-day terrestrial argon, because of a characteristically higher A^{36}/A^{40} . It seemed likely, therefore, that the magnetic fraction of red clay samples contains argon of cosmic origin in detectable amounts. These results have now been checked and confirmed by Merrihue and Tilles.

Suites of larger-grained magnetic material have been collected from twenty-five biological bottom-trawl samples. Preliminary examination of this material indicated that it consists of rust scale from the trawl, grains of magnetite, quartz grains with magnetic inclusions, heavy minerals, and unidentified opaque black grains. It should be interesting to see if this material, which is certainly in part (and probably all) of terrestrial origin, gives different argon results, and samples are being submitted to Merrihue for these determinations. If these probably terrestrial magnetite grains show the same high-temperature argon anomaly it could indicate that they crystallized in an atmosphere containing less A^{40} than at present. If they do not show the anomaly the supposition of the presence of a cosmic fraction in the magnetic red-clay separates would be strengthened.

D. Radioactivation analysis

1. Calibration of fast -vs slow- flux irradiations.

In the previous report it was shown that small samples of metallic aluminum could be irradiated in the presence of iron for five minutes at a distance of 10" above the top of the reactor core without causing a detectable $\text{Fe}^{56} (n,p) \text{Mn}^{56}$ reaction while at the same time producing appreciable Al^{28} from the $\text{Al}^{27} (n,\gamma) \text{Al}^{28}$ reaction. It was concluded that amounts of Al as small as 0.012 mg would be barely detectable under these conditions. Runs have now been made for 10 minutes at 10" above the top of the core with a series of samples much smaller than the earlier set but still containing more Al than the predicted lower limit of 0.012 mg for this position. Results were qualitative but not quantitative (see Table I) and it is clear that irradiations of small samples must be tried closer to the core.

Table I: Comparison of results in analyzing for Al.

All samples had ten-minute irradiations ten inches above top of reactor core.

<u>Sample</u>	<u>Total wt. Al (mg)</u>	<u>Al^{28} Count @ to</u>	<u>Counts/min./mg</u>
SSW1	8.09	25,000	3069
SS8	5.42	26,000	4797
SS6	4.71	16,500	3502
SS7	4.68	14,000	2991
SS13	4.23	15,000	3546

The same samples also contained Mg in varying amounts but a check of the decay of 9-10 minute Mg^{27} at the 0.84 Mev peak was even more discouraging. In this case the imprecision of the results might be improved by irradiation over several half-lives of the daughter product or by beta counting.

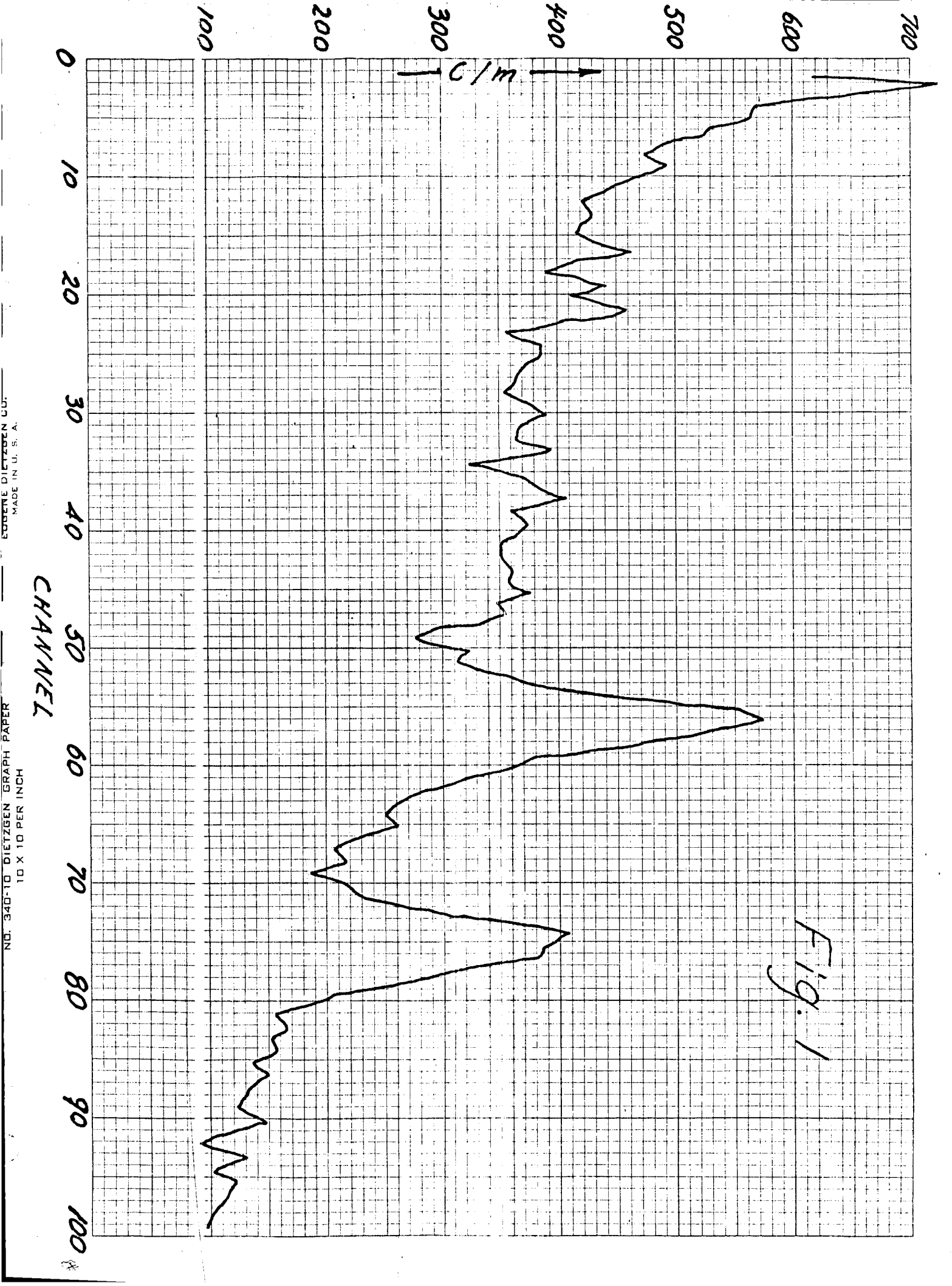
2. Compositional studies on unknowns.

A group of clear, transparent spherules had been collected and it was thought they were natural in origin. Irradiation and counting of a 150-micron and a 230-micron specimen, however, failed to indicate the presence of Fe, Mg, Na, Al, or Si (see Fig. 1). A spectrum of an undoubtedly siliceous 300-micron natural spherule is given in Fig. 2 for comparison. The low reactivity of these objects, combined with their physical appearance, suggested some type of resin, and their source was found to be a contaminant as outlined earlier. As of the date of this report, the spherule whose spectrum is given in Fig. 2 remains the only siliceous spherule of probable cosmic origin reported from ocean sediments. Photos of the contaminating spherules and of the natural siliceous spherule are given in Figs. 3 and 4, respectively.

Fig. 1. Irradiation spectrum of a transparent spherule 230 microns in diameter found in the magnetic collections. Absence of peaks at channels 28, 47, and 59 indicate absence of Fe, Mg, Na, Si, and Al in the spherule, therefore it cannot be a siliceous glass. Five minute irradiation; one minute count. Beginning of count 12.5 minutes after end of irradiation. Peaks unidentified.

Fig. 2. Irradiation spectrum of a transparent spherule 300 microns in diameter from ocean sediments. Note prominent peaks at channels 28, 47, and 59, indicating presence of Fe and/or Mg, Na, and Si and/or Al. Thirty second irradiation; one minute count. Beginning of count 14 minutes after end of irradiation.

Note that the two spectra of Fig. 1 and Fig. 2 are completely dissimilar.



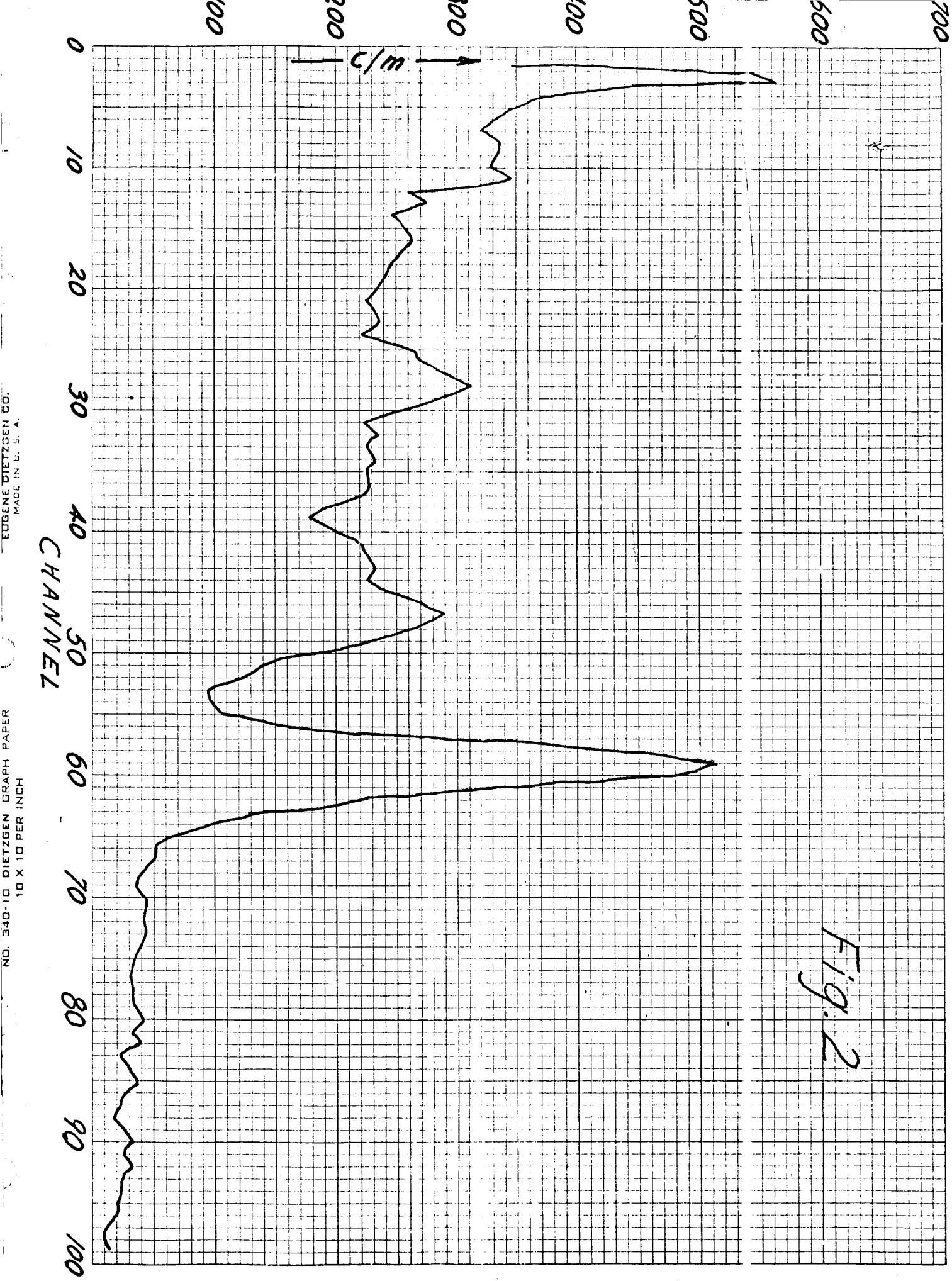


Fig. 2

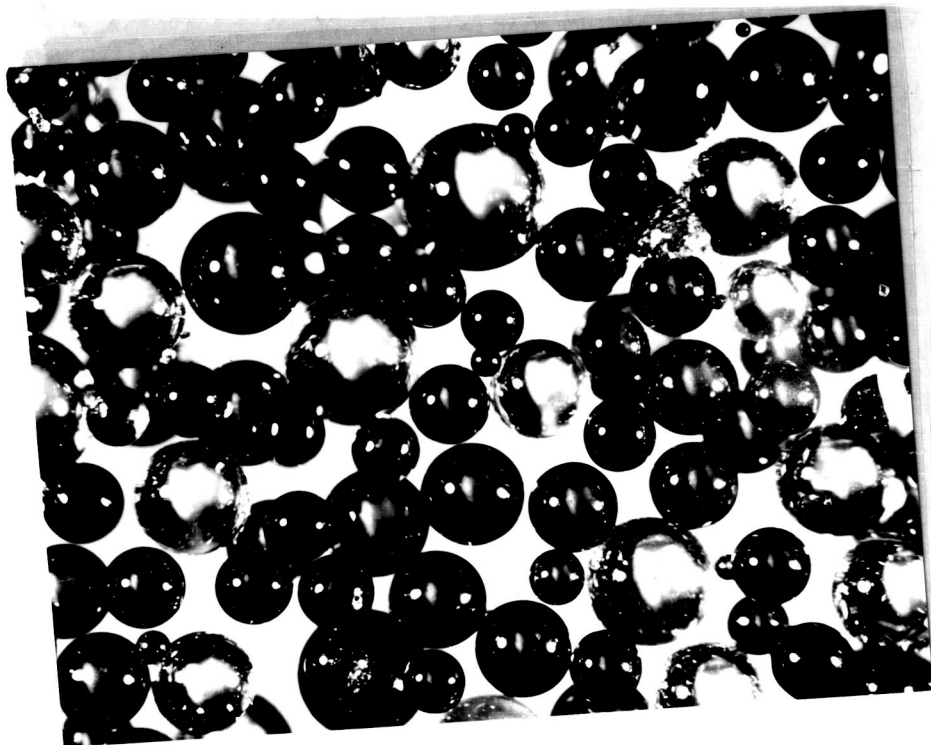


Fig. 3. Transparent spherules derived from ion-exchange cartridge.

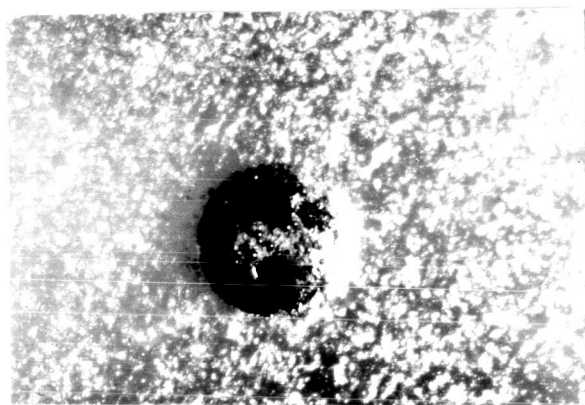


Fig. 4. Siliceous spherule of Fig. 2.

II. Bibliography

A. Paper resulting from project research.

William A. Cassidy, "Nondestructive Neutron-Activation Analysis of Small Particles," Annals, N.Y. Acad. Sci. 119(1), 318-38, 1964. (Twenty-two copies of this paper have been forwarded to the Technical Reports Officer, Grants & Research Contracts Division.)

B. Papers related to project research.

1. William A. Cassidy, "Experimental Data Bearing on Questions of Cosmic Dust Genesis," Annals, N.Y. Acad. Sci. 119(1), 17-40, 1964. (Reprints available from Author).

2. William A. Cassidy, "Report on Conference on Cosmic Dust," Science 144(3623), 1475-7, 1964. (Reprints available from Author).

3. Cosmic Dust, William A. Cassidy ed., N.Y. Acad. Sci., N.Y., 368 pp., 1964. (Copies available from the Academy).

4. William A. Cassidy, "Cosmic Dust," (encyclopedia entry in preparation).

5. William A. Cassidy, "Micrometeorites," (encyclopedia entry in preparation).

III. Projected Work

A. Magnetic and non-magnetic separations on flow-in samples.

Magnetic separation work will be continued in order to supply samples to those laboratories requiring them in their search for cosmogenic nuclides. Magnetic separations for spherules for our own collections will be continued concurrently.

Microscopic search of the 50-micron nonmagnetic fractions of red-clay cores will be continued.

B. Polished-section examinations.

Peel studies have been resumed and results will be reported in the future.

C. Trawling collections are being made continually by the VEMA, and examination of them for extraterrestrial material will continue.

D. Nondestructive radioactivation analysis.

Irradiation will be made in the vertical tube facility closer to the core and for longer durations. Longer duration runs will also be made in the rabbit facility. Beta-counting will be attempted, relying on identification by half-life decay.

E. Model studies.

Effects on the ocean floor of the impact of crater-producing meteorites on the ocean surface are not known, and a model study

is proposed to try to duplicate these conditions on a small scale.

PETN 400 Primacord will be used in the proposed experimental setup. This fuse type detonates explosively at a speed of 5 or more km/sec., and must produce a shock wave ahead of the traveling detonation point. It is expected that this will simulate the shock front traveling just ahead of a falling meteorite. In the experimental arrangement, one-foot lengths of fuse will be suspended both above, and just below, the surface of a pool of water of varying depth. Shock-wave cratering and explosion-plus-shock-wave cratering will be caused in the water surface, and any effects produced in the mud underlying the water will be noted (see diagram, Fig. 5).

The proposed experiments should provide general information to use in interpreting features of unknown origin noted on the ocean floor.

V. Acknowledgement

The opportunity to carry out the work described in this report, made possible by NASA Grant NsG 232-62, is gratefully acknowledged.

Respectfully submitted,

William A. Cassidy
Principal Investigator

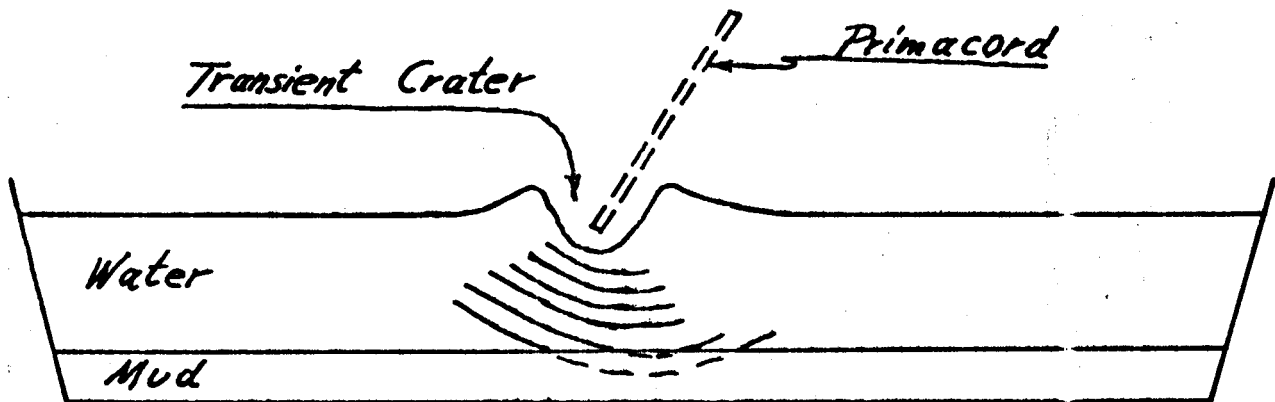


Fig. 5. Sketch of proposed model study. A transient crater is produced in the water and shock waves travel to the bottom, where presumably they produce some kind of blemish in the underlying mud.